3GPP TSG SA WG3 Security — S3#22 **S3-020031**

25 - 28 February 2002

Bristol, UK

3GPP TSG-SA WG2 meeting #22 **Tdoc S2-020326**
Phoenix, USA, 14 - 18 January 2002

Title:	Liaison Statement on "Prefix allocation for IPv6 stateless address autoconfiguration"
Source:	SA2
To:	T1, T2, SA3, SA5, CN1, CN3
Cc:	SA4, CN, T

Contact Person:
Name: Juan-Antonio Ibanez
E-mail Address: Juan-Antonio.X.Ibanez@erv.ericsson.se

Attachments: S2-020244, S2-020245, S2-020246 and S2-013330

1. Description:

SA2 would like to inform the above-mentioned groups that during its plenary meeting #22, SA2 has agreed that a unique IPv6 prefix shall be allocated to every primary PDP context when using the IPv6 stateless address autoconfiguration procedure. No particular requirements on IPv6 stateful address allocation have been discussed. The attached CRs to 23.060 have been approved, which introduce the changes to the IPv6 stateless address autoconfiguration procedure in GPRS from release 99 onwards. Also attached, the contribution S2-013330, which was presented in SA2#21, explains the reasons for this change. IPv6 prefix allocation will in particular allow UEs to freely change their interface identifier, for instance for privacy reasons (RFC 3041), without the need for the network to be involved. This also implies that the actual interface identifier used by the UE will not be known to the PLMN.

SA2 kindly asks the above-mentioned groups to consider these changes in their work and investigate possible impacts on their respective specifications. SA2 however has not identified any direct impacts on SA3 and SA5 specifications. Note also that these changes do not affect the SGSN.

2. Actions:

T1, T2, SA3, SA5, CN1 and CN3:
To consider these changes in their work and investigate possible impacts on their respective specifications.

3. Date of Next SA2 Meetings:

SA2 #23	18th – 22nd February 2002	Sophia-Antipolis, France
SA2 #24	22nd – 26th April 2002	Madrid, Spain

3GPP TSG-SA2 Meeting #22
Phoenix, USA, 14-18 January 2002

Tdoc S2-020244

CR-Form-v4

CHANGE REQUEST

⌘	**23.060**	**CR**	**286**	⌘	ev	**2**	⌘	Current version:	**5.0.0** ⌘

For ***HELP*** *on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [ ] Core Network [X]

Title: ⌘	Allocation of unique prefixes to IPv6 terminals		
Source: ⌘	Ericsson		
Work item code: ⌘	IMS-CCR	***Date:*** ⌘	15 January 2002
Category: ⌘	**A**	***Release:*** ⌘	R5
	Use one of the following categories: ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change: ⌘	The current mechanism for IPv6 stateless address autoconfiguration defined in 23.060 is not aligned with the standard IETF mechanism and as such is prone to incompatibilities with future developments of IPv6. Already some features of IPv6 have been identified that do not work properly with the current mechanism (e.g. privacy extensions for IPv6 defined in RFC 3041). In order to avoid such incompatibilities, today and in the future, it is therefore essential to align the support of IPv6 in GPRS/UMTS with the mechanisms defined in the IETF. Since IMS mandates the use of IPv6 in Release 5 and addressing is an essential aspect of the architecture, such alignment has to be considered in the same timeframe, i.e. in Release 5, so as to avoid backward compatibility problems, with terminals in particular, if these changes were to be introduced later. This CR corrects the current shortcomings of the IPv6 stateless address autoconfiguration in 23.060, mainly by specifying that a different prefix shall be allocated to each PDP context that uses stateless address autoconfiguration. This principle is recommended in the Internet-Draft "draft-wasserman-3gpp-advice-00.txt", which has been produced by a design team composed of IETF IPng experts that have investigated the use of IPv6 in the 3GPP architecture. It shall be noted that these experts do not believe that this principle could lead to an over-consumption of the vast IPv6 addressing space, as indicated in the Internet-Draft. Note that the IETF IPng working group has adopted this Internet-Draft as working group item in the last IETF meeting (Dec 2001), with the intention to quickly progress it to the status of informational RFC.
Summary of change: ⌘	The IPv6 stateless address autoconfiguration procedure is modified to support allocation of a distinct prefix to each PDP context.

Consequences if not approved:	⌘	The support of IPv6 stateless address autoconfiguration in GPRS will not be aligned with the standard IETF mechanism and therefore risks not being compatible with future developments of IPv6 in IETF.

Clauses affected:	⌘	9.2.1.1			
Other specs affected:	⌘	☐	Other core specifications	⌘	
		☐	Test specifications		
		☐	O&M Specifications		
Other comments:	⌘	It shall be noted that only the UE and the GGSN are impacted by these changes. The SGSN remains untouched.			

9.2.1.1 Dynamic IPv6 Address Allocation

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IPv6 stateful address autoconfiguration uses the standard External PDN Address Allocation procedure, as described in 3GPP TS 29.061 [27]. The GGSN informs the MS that it shall perform ~~requests~~ stateful address autoconfiguration by means of the Router Advertisements, as defined in RFC 2461[71]. The use of stateless or stateful address autoconfiguration is configured per APN.~~using an Access Point Name referring to that service.~~

In order to support the standard IPv6 stateless address autoconfiguration mechanism, as defined by the IETF, within the particular context of UMTS (point-to-point connections, radio resource efficiency, etc), the GGSN shall assign a prefix that is unique within its scope to each PDP context applying IPv6 stateless address autoconfiguration. The size of the prefix is according to the maximum prefix length for a global IPv6 address. This avoids the necessity to perform duplicate address detection ~~on~~at the network level for every address built by the MS.

To support terminals that cannot generate an interface identifier by themselves, ~~dynamic IPv6 address allocation by the PLMN operator,~~ the GGSN shall always provide~~s a unique~~ an interface identifier (see RFC 2462 [69]) to the MS. If the MS is capable of generating its own interface identifier, the MS may ignore the interface identifier provided by the GGSN. ~~This enables the MS to perform the IPv6 stateless autoconfiguration procedures to generate its full IPv6 address.~~

Figure 1 illustrates the IPv6 stateless autoconfiguration procedure~~s for this case~~.

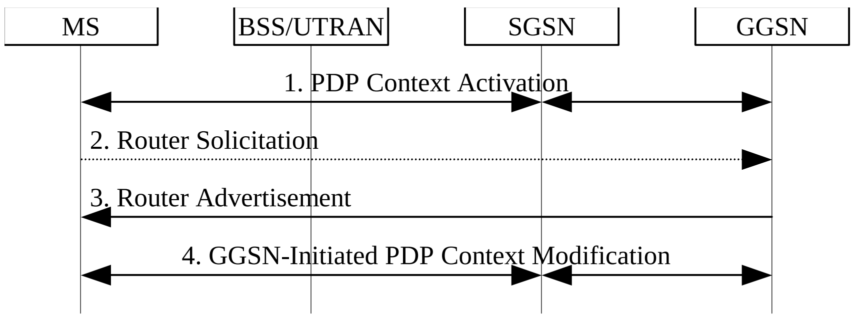

Figure 1: IPv6 Stateless Address Autoconfiguration Procedure

1) The MS sends an Activate PDP Context Request message to the SGSN. The procedure follows that defined in clause "PDP Context Activation Procedure" with the exceptions described below.

   The MS shall leave PDP Address empty and set PDP Type to IPv6. The GGSN shall create ~~the unique~~ a link-local address for the MS and send it in the PDP Address information element in the Create PDP Context Response message. The link local address consists of a fixed 10-bit prefix (IPv6 well-known link-local prefix), zero or more 0 bits, and the interface identifier.

NOTE: Since the MS is considered to be alone on its link towards the GGSN, the link-local address, and therefore the interface identifier, does not need to be unique across all PDP contexts.

2) The MS may send a Router Solicitation message to the GGSN to activate the sending of the Router Advertisement message.

3) The GGSN ~~should~~ shall automatically and periodically send ~~the~~ Router Advertisement messages after the PDP context is activated. A given prefix shall not be advertised on more than one PDP context on a given APN, or set of APNs, within the same addressing scope. ~~In release 99 t~~The GGSN shall be configured to advertise only one ~~network~~ prefix per ~~APN~~PDP context.

   After the MS has received the Router Advertisement message, it constructs its full IPv6 address by concatenating the interface identifier contained in the link-local address provided in ~~the Create PDP Context Response Message in~~ step 1, or a locally generated interface identifier, and the ~~network~~ prefix ~~of the selected APN~~ received in the Router Advertisement. Subsequently, the MS is ready to start communicating to the Internet.

Because any prefix that the GGSN advertises in a PDP context is unique within the scope of the prefix (i.e. site-local or global) provides a unique interface identifier during the PDP context activation procedure, there is no need for the MS to perform Duplicate Address Detection for this IPv6 address. Therefore, the GGSN shall intercept and silently discard Neighbor Solicitation messages that the MS may send to perform Duplicate Address Detection. It is possible for the MS to perform Neighbor Unreachability Detection towards the GGSN, as defined in RFC 2461[71]; therefore if the GGSN receives a Neighbor Solicitation as part of this procedure, the GGSN shall provide a Neighbor Advertisement as described in RFC 2461.

4) The GGSN updates the PDP context in the SGSN and MS with the full IPv6 addressa PDP address consisting of the prefix being advertised followed by all ones, see clause "GGSN-Initiated PDP Context Modification Procedure".

3GPP TSG-SA2 Meeting #22
Phoenix, USA, 14-18 January 2002

Tdoc S2-020245

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CHANGE REQUEST

⌘	**23.060**	**CR**	**305**	⌘	ev	**-**	⌘	Current version:	**3.10.0**	⌘

For ***HELP*** *on using this form, see bottom of this page or look at the pop-up text over the ⌘ symbols.*

Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [ ] Core Network [X]

Title:	⌘	Allocation of unique prefixes to IPv6 terminals		
Source:	⌘	Ericsson		
Work item code:	⌘	TEI	***Date:*** ⌘	15 January 2002
Category:	⌘	**F** *Use one of the following categories:* ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.	***Release:*** ⌘	R99 *Use one of the following releases:* 2 *(GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change: ⌘

The current mechanism for IPv6 stateless address autoconfiguration defined in 23.060 is not aligned with the standard IETF mechanism and as such is prone to incompatibilities with future developments of IPv6. Already some features of IPv6 have been identified that do not work properly with the current mechanism (e.g. privacy extensions for IPv6 defined in RFC 3041). In order to avoid such incompatibilities, today and in the future, it is therefore essential to align the support of IPv6 in GPRS/UMTS with the mechanisms defined in the IETF.

This CR corrects the current shortcomings of the IPv6 stateless address autoconfiguration in 23.060, mainly by specifying that a different prefix shall be allocated to each PDP context that uses stateless address autoconfiguration.

This principle is recommended in the Internet-Draft “draft-wasserman-3gpp-advice-00.txt”, which has been produced by a design team composed of IETF IPng experts that have investigated the use of IPv6 in the 3GPP architecture.
It shall be noted that these experts do not believe that this principle could lead to an over-consumption of the vast IPv6 addressing space, as indicated in the Internet-Draft.

Note that the IETF IPng working group has adopted this Internet-Draft as working group item in the last IETF meeting (Dec 2001), with the intention to quickly progress it to the status of informational RFC.

This CR is a mirror to CR 286 for R5. The reason why corresponding CRs for R99 and R4 are needed, in addition to the reasons above, is to avoid backward compatibility problems and to ensure a consistent architecture across releases when it is still possible. The changes are indeed simple and limited and can therefore easily be introduced in R99/4 standards. Should any terminal already implement the current procedure, it will still work with these modifications implemented elsewhere in the network.

Summary of change:	⌘	The IPv6 stateless address autoconfiguration procedure is modified to support allocation of a distinct prefix to each PDP context.
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Clauses affected:	⌘	9.2.1.1		
Other specs affected:	⌘	☐ Other core specifications	⌘	
		☐ Test specifications		
		☐ O&M Specifications		
Other comments:	⌘	It shall be noted that only the UE and the GGSN are impacted by these changes. The SGSN remains untouched.		

9.2.1.1 Dynamic IPv6 Address Allocation

IPv6 address allocation is somewhat different from the IPv4 address allocation procedure. There are two possibilities to allocate the address for an IPv6 node – stateless and stateful autoconfiguration. The stateful address allocation mechanism needs a DHCP server to allocate the address for the IPv6 node. In the stateless autoconfiguration, the IPv6 node is more involved in the allocation of the address. In addition, the stateless autoconfiguration procedure does not need any external entity involved in the address autoconfiguration.

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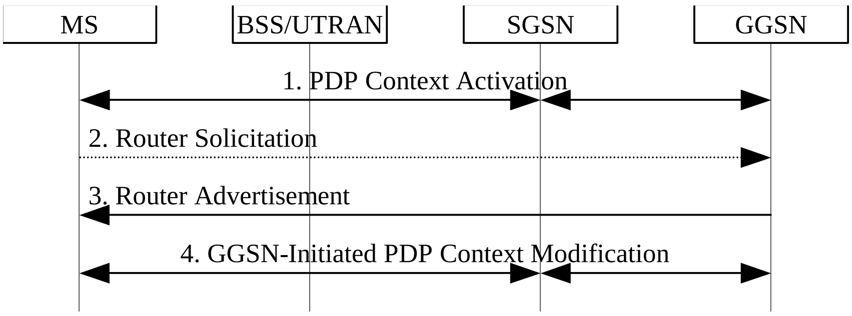
Figure 1 illustrates the IPv6 stateless autoconfiguration procedure~~s for this case~~.



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3GPP TSG-SA2 Meeting #22
Phoenix, USA, 14-18 January 2002

Tdoc S2-020246

CR-Form-v4

CHANGE REQUEST

⌘	**23.060**	**CR**	**306**	⌘	ev	**-**	⌘ Current version:	**4.3.0** ⌘

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Proposed change affects: ⌘ (U)SIM [ ] ME/UE [X] Radio Access Network [ ] Core Network [X]

Title:	⌘	Allocation of unique prefixes to IPv6 terminals		
Source:	⌘	Ericsson		
Work item code:	⌘	TEI-4	***Date:*** ⌘	15 January 2002
Category:	⌘	**A**	***Release:*** ⌘	R4
		Use one of the following categories: ***F*** *(correction)* ***A*** *(corresponds to a correction in an earlier release)* ***B*** *(addition of feature),* ***C*** *(functional modification of feature)* ***D*** *(editorial modification)* Detailed explanations of the above categories can be found in 3GPP TR 21.900.		*Use one of the following releases:* *2 (GSM Phase 2)* *R96 (Release 1996)* *R97 (Release 1997)* *R98 (Release 1998)* *R99 (Release 1999)* *REL-4 (Release 4)* *REL-5 (Release 5)*

Reason for change: ⌘

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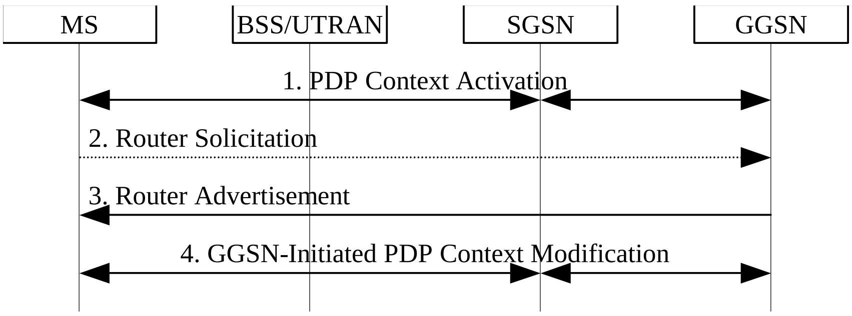

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3GPP TSG-SA2 Meeting #21 ***Tdoc S2-013330***
Cancun, Mexico, 26-30 November 2001

Agenda Item: **Rel-5 (IPv6)**
Source: **Ericsson**
Title: **IPv6 stateless address autoconfiguration in GPRS**
Document for: **Discussion and decision**

1. Introduction

In R’99 was introduced a mechanism to support IPv6 stateless address autoconfiguration as described in section 9.2.1.1 of 23.060. This mechanism, however, has some limitations compared to the standard IPv6 stateless address autoconfiguration as defined in RFC 2462.

As mentioned in Ericsson’s tdoc S2-013329, submitted to this meeting, a design team within the IETF IPng working group has analyzed the current use of IPv6 in 3GPP and has also identified these limitations as issues that need to be resolved.

This contribution presents the IPv6 stateless address autoconfiguration mechanism as supported by GPRS and discusses a basic problem with this mechanism, namely the fact that it cannot be assumed that the MS will not use any other interface identifier than the one provided by the GGSN at PDP context activation. A proposal for the way forward is then formulated.

2. Discussion

2.1 Stateless Address Autoconfiguration according to RFC 2462

Summarized in a few lines the IPv6 stateless address autoconfiguration works as follows.

The host first generates a link-local address by appending an interface identifier of its choice to the well-known link-local prefix (i.e. FE80::0). The host then performs Duplicate Address Detection (DAD) to check if another host on the same link is not already using this address. This is done by multicasting Neighbor Solicitation messages, with the tentative address as Target Address, to all the nodes on the same link. If the host receives a Neighbor Advertisement in response to the Neighbor Solicitation, then the address is already in use and the host needs to select a new interface identifier or, if not possible, the autoconfiguration fails.

If the address is actually unique, the host will then wait for a Router Advertisement from a router or solicit one by sending a Router Solicitation. The Router Advertisement carries one or more network prefixes that allow the host to construct its global and site-local addresses by combining each network prefix with its link-local address.

2.2 The Stateless Address Autoconfiguration today in GPRS

Section 9.2.1.1 from TS 23.060 describing the IPv6 stateless address autoconfiguration procedure in GPRS (for both R’99 and R4) is reproduced hereafter.

9.2.1.1 Dynamic IPv6 Address Allocation

IPv6 address allocation is somewhat different from the IPv4 address allocation procedure. There are two possibilities to allocate the address for an IPv6 node – stateless and stateful autoconfiguration. The stateful address allocation mechanism needs a DHCP server to allocate the address for the IPv6 node. In the stateless autoconfiguration, the IPv6 node is more involved in the allocation of the address. In addition, the stateless autoconfiguration procedure does not need any external entity involved in the address autoconfiguration.

IPv6 stateful address autoconfiguration uses the standard External PDN Address Allocation procedure, as described in TS 29.061 [27]. The MS requests stateful address autoconfiguration by using an Access Point Name referring to that service.

To support dynamic IPv6 address allocation by the PLMN operator, the GGSN provides a unique interface identifier (see RFC 2462 [69]) to the MS. This enables the MS to perform the IPv6 stateless autoconfiguration procedures to generate its full IPv6 address. Figure 1 illustrates the IPv6 stateless autoconfiguration procedures for this case.

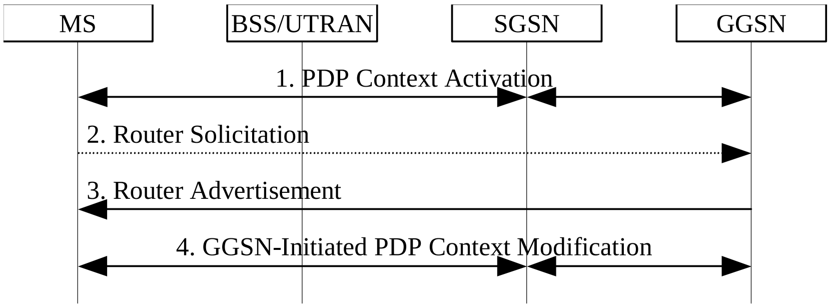

Figure 1: IPv6 Stateless Address Autoconfiguration Procedure

1) The MS sends an Activate PDP Context Request message to the SGSN. The procedure follows that defined in subclause "PDP Context Activation Procedure" with exceptions described below.

   The MS shall leave PDP Address empty and set PDP Type to IPv6. **The GGSN shall create the unique link-local address for the MS** and send it in the PDP Address information element in the Create PDP Context Response message. The link local address consists of a fixed 10-bit prefix (IPv6 well-known link-local prefix), zero or more 0 bits, and the interface identifier.

2) The MS may send a Router Solicitation message to the GGSN to activate the sending of the Router Advertisement message.

3) The GGSN should automatically send the Router Advertisement message after the PDP context is activated. In release 99 the GGSN shall be configured to advertise only one network prefix per APN.

   After the MS has received the Router Advertisement message, it constructs its full IPv6 address by concatenating the interface identifier contained in the link-local address provided in the Create PDP Context Response Message in step 1 and the network prefix of the selected APN received in the Router Advertisement. Subsequently, the MS is ready to start communicating to the Internet.

   Because the GGSN provides a unique interface identifier during the PDP context activation procedure, there is no need for the MS to perform Duplicate Address Detection for this IPv6 address. Therefore, the GGSN shall intercept and discard Neighbor Solicitation messages that the MS may send to perform Duplicate Address Detection. It is possible for the MS to perform Neighbor Unreachability Detection, as defined in RFC 2461[71]; therefore if the GGSN receives a Neighbor Solicitation as part of this procedure, the GGSN shall provide a Neighbor Advertisement as described in RFC 2461.

4) The GGSN updates the PDP context in the SGSN and MS with the full IPv6 address, see subclause "GGSN-Initiated PDP Context Modification Procedure".

2.3 Problem with the current procedure and proposed solution

During the introduction of IPv6 stateless auto-configuration support in 3GPP R’99, it was deemed necessary to introduce a mechanism that makes the Duplicate Address Detection (DAD) procedure superfluous. The main reason for this choice was that handling of DAD in the GGSN would be a quite complex task.

Since in GPRS every MS has a point-to-point connection to the GGSN and since PPP is the most common link protocol between TE and MT (if not the only one), the IPv6 stateless autoconfiguration procedure was based on the mechanism defined in RFC 2472, i.e. for IPv6 over PPP. Over a PPP link, it is possible for one end to suggest an interface identifier to the other end, end that is what the GGSN does today.

In SA2 it was assumed that the GGSN could enforce the interface identifier that the MS must use by means of this PPP feature. With this assumption the need to perform DAD becomes redundant and the GGSN can simply ignore DAD messages (i.e. silently discard them).

But since then, the IETF has been working towards further evolving and improving the handling of IPv6 address autoconfiguration. One of the issues that the IETF has addressed is the issue of Privacy and security of an assigned IPv6 address being used for a prolonged period, as described in the RFC 3041, section 2.3. To this effect, RFC 3041 introduces the concept of temporary addresses. Temporary addresses have a short lifetime and are periodically generated by selecting a new pseudo-random interface identifier. This work has been completed in January 2001, i.e. after 3GPP completion of R'99. Any laptop connected via a 3GPP MT and supporting this RFC would send DAD messages and attempt to verify uniqueness of any new temporary address generated according to this RFC. Discarding DAD messages in the GGSN would result in the MS starting to use an address that the GGSN doesn't know, thus making the MS unable to communicate with that address. This would in turn result in a bad perception of the service from users experiencing a stalling of their application after a couple of hours, when the laptop first attempts to change its address (and believes it succeeded).

The IETF IPng design team mentioned above has identified this issue and has formulated a proposal to 3GPP on how to solve this problem. The proposed solution is to allocate a distinct 64-bit prefix to each PDP context. In this way the MS (or TE) could select whatever interface identifier it whishes without requiring the GGSN to know it since the PDP context would be identified by the prefix rather than the full IPv6 address. This would also make DAD redundant as no other terminal would be sharing the same prefix. The internet-draft produced by the design team also explains that the IPv6 address space is large enough to never be exhausted by terminals (or rather PDP contexts) getting a 64-bit prefix for their own use. From draft-wasserman-3gpp-advice-00.txt:

"*Using these assumptions, a total of 490 trillion (490x10^12) /64 prefixes can be assigned. This translates into around 80,000 PDP Contexts per person on the earth today. Even assuming that a majority of these IPv6 /64 prefixes will be used by non-3GPP networks, there is still clearly a sufficient number of /64 prefixes.*"

It is also worth noting that allocating a prefix to each PDP context inherently solves an issue that has not been addressed by 3GPP so far, namely the support of mobile devices that can work as routers for a local or personal area network attached to them.

2.4 When to solve the problem?

It is important to better align the use of IPv6 in 3GPP with the basic principles defined in the IETF so as to ensure that the 3GPP architecture will remain compatible with future evolutions of IPv6. Moreover, addressing is an essential aspect of any architecture and hence requires a particular attention.

Release 5 is a critical milestone for IPv6 in 3GPP since IPv6 is the only option for the IMS, which will come to life in release 5. It is therefore important that at the latest in release 5 the IPv6 addressing architecture in 3GPP is adequately aligned with IETF.

However release 99 terminals will be available in large amounts when the first release 5 networks will be deployed. In the meantime, other IPv6 networks are likely to be deployed, in particular in countries where operators can only get a very limited number of IPv4 addresses compared to the number of mobile users. It is therefore sensible, if not critical, to consider introducing these changes in R'99 already, so as to give the right start to IPv6 in 3GPP and avoid bad user perception. Obviously, backward compatibility issues with respect to R'99/R4 terminals shall be considered when deciding in which release to introduce the changes.

It shall also be noted that the changes required in the standards to support individual prefixes per PDP context are rather simple and limited and can therefore be easily introduced in R'99/R4 standards. From an implementation point of view, allocating prefixes per PDP context is very similar to allocating dynamic addresses from a pool in the GGSN, therefore limited engineering effort would be required in this respect as well.

3. Proposal

1. Agree on the allocation of a unique IPv6 prefix per PDP context and introduce the necessary changes to the IPv6 stateless address autoconfiguration procedure in TS 23.060 for release 5. A corresponding CR is proposed in S2-013331.
2. In order to avoid backward compatibility problems and to give IPv6 a right start in 3GPP, introduce the prefix allocation in 23.060 for release 99 and release 4 as well. Similar CRs as for R5 would be applicable.

4. References

RFC 2462 "*IPv6 Stateless Address Autoconfiguration*",
S. Thomson, T. Narten, Standards Track, December 1998

RFC 2472 "*IP Version 6 over PPP*",
D. Haskin, E. Allen, Standards Track, December 1998

RFC 3041 "*Privacy Extensions for Stateless Address Autoconfiguration in IPv6*",
T. Narten, R. Draves, Standards Track, January 2001